SECTION 6

Engineering and Design Criteria

6.1 Introduction

This design criteria section is intended to provide guidelines for performing detailed engineering and plant design for the Modesto Irrigation District (MID) Electric Generation Station (MEGS) to be located in the City of Ripon (City), California.

6.1.1 General Plant Description

The plant will consist of two 50-MW gross GE LM6000 SPRINT model combustion turbine generators (CTG) with inlet air chilling operating in simple-cycle. The nominal net electrical output of the plant will be 95 MW.

6.1.2 Codes and Standards

The plant design shall be in accordance with, but not limited to, the codes and standards in all applicable sections and subsections and in the latest editions.

TABLE 6-1
MEGS Codes and Standards

AASHTO	American Association of State Highway Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving and Conditioning Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials Standards
AWS	American Welding Society
CBC	California Building Code, 1998
CFR	Code of Federal Regulations, Title 29, Chapter XVII, Part 1910
CTI	Cooling Tower Institute
HI	Hydraulic Institute Standards
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
MSS	Manufacturers Standardization Society Practices

NEC	National Electrical Code (NFPA No. 70)
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
SSPC	Steel Structures Painting Council
UL	Underwriter Laboratories Incorporated
UPC	Uniform Plumbing Code
USEPA	U.S. Environmental Protection Agency

6.1.3 Site Design Data

Table 6-2 indicates MEGS site design elements.

TABLE 6-2
Site Design Elements

Location:	City of Ripon, California
Elevation above sea level (ft):	60
Design Temperature Range (°F):	32 to 102
Extreme Temperature Range (°F):	15 to 115
Average Annual Temperature (°F):	67
Relative Humidity Range (%):	10 to 100
Average Annual Rainfall (inches):	11.95
Maximum Rainfall 24 Hours (inches):	2.50
Design Wind Speed, (MPH):	70 MPH Basic Wind Speed per CBC
Seismic Design (CBC Zone):	3
Average Equipment Noise Level 3 feet from the outline of equipment:	85 dBA
Noise Level Outside Plant Property Line:	70 dBA (Max.)
Plant Design Life (years):	30

6.2 Mechanical

6.2.1 General Design Requirements

6.2.1.1 Plant Operating Requirements

The plant will consist of two GE LM6000 SPRINT combustion turbine generators with inlet air chilling operating in simple cycle designed to generate, at full load, 95 MW of net electrical power output while operating on natural gas fuel at a summer ambient temperature of 102 °F and 20 percent relative humidity (RH).

The plant will be a central component of the Modesto Irrigation District power resource base and as such shall be designed to operate under the following conditions:

- The plant will be designed to operate for peaking service for MID customers.
- The plant will be designed for flexible load-following and cyclic-duty capabilities.
- The plant shall be capable of daily start-up from the cold shutdown condition and shall be able to achieve full load condition in the least amount of time as is possible.
- The plant shall be designed with the ability to operate within the load range of approximately 10 percent to full load (10 MW to 95 MW plant net).
- The plant shall be designed to operate in the environment and conditions specific to the site and shall meet all the performance and emissions specified herein.
- The plant will be staffed during normal operation. However, to the extent that is practical, all normal operating and controlling functions shall be fully automated.

6.2.1.2 Fuels

The combustion turbines will be designed to use natural gas fuel only.

6.2.1.3 Plant Emissions

Nitrous Oxide Control

The plant will be designed for water injection into the combustion turbines at a rate that will result in nominal nitrogen oxide (NO_x) emissions of 30 parts per million by volume, dry (ppmvd) corrected to 15 percent oxygen (@ 15 percent O_2) at the combustion turbine exhaust during full load operation and natural gas firing. In addition, the plant will be equipped with a highly efficient Selective Catalytic Reduction (SCR) System that will further reduce NO_x emissions to 2.5 ppmvd @ 15 percent O_2 at the plant stack. Twenty-nine percent aqueous ammonia will be used in conjunction with an SCR catalyst system. The ammonia slip from the SCR system will be limited to less than 10 ppmvd @ 15 percent O_2.

Carbon Monoxide and Reactive Organic Compounds Control

The combustion turbines will be equipped with high efficiency combustors that will minimize the formation of carbon monoxide (CO) and reactive organic compounds (ROCs). In addition, the plant will be equipped with an oxidation catalyst system. Carbon monoxide limit at the stack will be 6 ppmvd @ 15 percent O_2.

6.2.1.4 Equipment Design Basis

A plant design service life of 30 years will be used as the basis for plant and equipment design. Equipment or components for which a 30-year life expectancy cannot be reasonably assured will be designed and installed to allow safe and convenient replacement.

The guaranteed operating point for major equipment will be selected at the combustion turbine base load rating corresponding to a summer ambient temperature of 102 °F and 20 percent RH, with the CTG inlet air chilled to 48 °F.

The power block equipment, as well as the balance of plant equipment, will be designed to meet the maximum operation conditions and requirements for each specific component or system.

6.2.1.5 Plant Interfaces with Utilities

Natural Gas

Natural gas will be supplied to the site via a new 8-inch-diameter pipeline from Pacific Gas and Electric Company (PG&E). The design gas supply pressure at the plant property line will range from 200 to 400 psig. The CTGs require a fuel pressure of approximately 675 psig. Therefore, the plant will be provided with three 50-percent gas compressors. The gas compression system will be designed to maintain a constant compressor outlet pressure with varying PG&E suction pressures. The PG&E fuel gas analysis is given in Appendix 6-1.

Water

Raw water for plant process needs will be taken from the City of Ripon non-potable water system, an existing municipal well water system. A representative non-potable water analysis is given in Appendix 6-2.

Potable water for plant domestic uses will be taken from the City's potable water supply.

Wastewater

Process wastewater will be discharged to the City's sanitary sewer system after appropriate onsite treatment. A process wastewater analysis from all plant wastewater sources is given in Appendix 6-3. Domestic wastewater will be discharged to the City's sanitary sewer system. Stormwater runoff will be directed to the City's existing stormwater collection system.

6.2.2 Mechanical Systems and Equipment

6.2.2.1 Combustion Turbine Generator

The CTGs will be GE LM6000 PC SPRINT aircraft-derivative type, water-injected for NO_x control, and designed to operate on natural gas fuel.

During continuous full-load operation with natural gas fuel, 5-inch water column inlet loss and 12-inch water column exhaust loss, 102 °F and 20 percent RH ambient conditions, inlet chilling to 48 °F, and water injection for NO_x control to 30 ppmvd @ 15 percent O_2, each CTG design performance is expected to be:

Gross Output (kW)	50,130
Fuel Consumption (HHV) (MMBtu/hr)	471
Exhaust Gas Flow (lb/hr)	1,079,974
Exhaust Gas Temperature (°F)	831

Each CTG package will include the following subsystems and features.

Turbine Generator Electrical System

The system shall include, but not be limited to:

- A 13.8-kV, 3-phase, 60-Hz, 71-MVA, 3600-rpm generator rated to exceed the capacity of the combustion turbine operating at 40 °F inlet air temperature
- VAR control (0.85 lead—0.85 lag)
- Low maintenance brushless excitation system, including automatic voltage regulator, power factor control system, and voltage control system
- Neutral and line-side cubicles with current transformers, surge protection capacitors, lightning arrestors, and neutral grounding transformer with secondary side resistor
- Generator circuit breaker
- Protective relay system
- Direct Current (dc) auxiliary power system, including a 24-volt battery system and solid-state automatic battery chargers for operation of CTG control system
- Class F insulation with Class B temperature rise

In addition, the CTG package will include all auxiliary motors, controls, control panels, motor control centers, internal wiring, and protective monitoring and alarm equipment required for the proper operation of the features described above and for the following subsystems.

Inlet Air Filtration/Silencing System

A multistage inlet air filtration/silencing system designed to protect the combustion turbine from the effects of airborne dust and dirt, achieve optimum system performance with minimum maintenance requirements, and meet operational and system criteria.

A filtration system consisting of weather hoods, protective screens, inertial separator, and final barrier filter. The minimum system efficiency shall be 99.9 percent removal of all particles 5.0 microns or larger.

The inlet air system will also include:

- Intake air silencer to limit equipment noise level below 85 dBA at 3 feet
- Inlet air chilling coil
- Self-contained air inlet heating system for anti-icing protection

The system will also include ducting to air plenum chamber, structural supports, platforms, and ladders. The filter housing will have service doors and internal lighting. The filter housing and supports shall be constructed with corrosion-resistant materials.

Turbine Enclosure

An insulated acoustical enclosure for the combustion turbine will be designed to meet the project sound attenuation requirements listed in Section 8.5. The enclosure shall be fabricated or protected with corrosion-resistant materials.

The turbine enclosure will be fully ventilated. The enclosure will be equipped with suitable lighting, access doors, and removable panels to facilitate turbine inspection and maintenance. To prevent any fuel from leaking from the turbine enclosure, a negative pressure shall be maintained in the turbine compartment during normal operation.

Stairs and access platforms will be required around the enclosure for safe and easy access to the turbine package. The platforms will be removable if necessary to gain access in the turbine removal area.

Fuel Systems and Water Injection System

The combustion turbine will be designed to operate on natural gas fuel with water injection for NO_x control. The fuel system will be designed to automatically control the fuel supply to the combustion turbine at any power level or operating condition. The fuel system will consist of a pressure-regulating valve, fuel control valve, shut-off valves, and instrumentation.

The water injection system will automatically control the combustor nozzle water injection rate. The system will include a control valve, shut-off valve, and instrumentation.

Starting System

The combustion turbines will be equipped with an electro-hydraulic starting system consisting of an electric-motor-driven hydraulic pump, a hydraulic oil reservoir and high-pressure filter assembly. The system will be designed for required purge cycles of the SCR/CO catalyst ducting and will also be capable of supporting off-line water wash operations. The CTG start motor is rated at 200 hp.

Lubricating Oil Systems

Separate lubricating oil systems shall be provided for the combustion turbine and for the generator:

- The combustion turbine lube oil system will provide clean and cool lubricating oil to the combustion turbine bearings, accessory drive gears, and shaft splines. The system will include a lube oil reservoir, a shaft-driven lube oil pump and backup direct-current motor-driven lube-oil pump, duplex filters, shell and tube coolers, and all interconnecting piping, strainers, valves, controls, and instrumentation.
- The generator lube oil system will provide clean and cool lubricating oil to the generator bearings. The system will include a lube oil reservoir, a main lube oil pump, dc-auxiliary pre/post lube oil pumps or gravity rundown system, duplex filters, shell and tube oil

coolers, and all the required interconnecting piping, strainers, valves, controls, and instrumentation.

All lube oil piping, strainers, coolers, and reservoirs will be of stainless steel construction.

Fire Detection and Protection System

The turbine enclosures will be equipped with a complete and automatic CO_2 fire detection and protection system that includes optical flame detectors, hydrocarbon sensing, and thermal detectors in both the turbine and generator compartments. In addition, the system will also include an automatic fire extinguishing system.

Water Wash System

The system will be fully automatic and designed to allow on-line and off-line cleaning of the turbine compressor section. The system consists of a fluid reservoir, pump, piping, valves, and controls.

6.2.2.2 Selective Catalytic Reduction System

The CTG exhaust will be provided with a selective catalytic reduction (SCR) system. The SCR system will be designed to reduce and maintain the emissions of NO_x from the CTG exhaust gases below the air permit requirements. The SCR system will use 29 percent aqueous ammonia. The system design will be as follows:

- CTG exhaust NO_x prior to SCR catalyst (30 ppmvd @ 15 percent O_2)
- Stack NO_x (2.5 ppmvd @ 15percent O_2)
- Ammonia slip at stack (10 ppmvd @15 percent O_2)
- Ammonia air dilution skid with electric vaporizer and dilution air fans
- Ammonia injection grid
- Ammonia balance skid (with tunable flow control valves and local indicating flow gauges on each header)
- Flue gas cooling air fans to protect the catalyst systems from high temperature
- SCR catalyst modules with provisions for periodic replacement
- Provisions for additional space for future installation of one row of catalyst

6.2.2.3 CO Catalyst System

The CTG exhaust will be provided with a CO catalyst system. The CO catalyst system will be designed to oxidize carbon monoxide emissions from the CTG exhaust gases and maintain these emissions below the air permit limits. The system design will be as follows:

- CTG exhaust CO (18 ppmvd @ 15 percent O_2)
- Stack CO (6 ppmvd @ 15 percent O_2)
- The system will consist of a catalyst bed located within the CTG exhaust ductwork and upstream of the SCR system.

6.2.2.4 Continuous Emission Monitoring System

The continuous emission monitoring (CEM) system will provide analysis and documentation for compliance of emissions monitoring for NOx, CO, and O_2 parameters.

An extractive type CEM system will be provided. Local to each exhaust stack, a monitoring station with a walk-in enclosure will be provided. This enclosure contains the sampling trains and monitoring instruments for analyzing the exhaust gas samples from the CTG exhaust stack. System accuracy will be in accordance with USEPA and air permit requirements.

The analyzer data along with fuel measurements shall be transmitted to a CEM Data Acquisition System (DAS) workstation (HMI) located in the control room, where calculations will be performed that will determine and record compliance with emissions controls and regulations. Reports will be generated in a format approved by the local Air District (for part 60 reporting) and USEPA (for CFR part 75 reporting).

A trim signal will be provided from the CEM system to the plant control system for NOx trim and SCR system control.

6.2.2.5 CTG Inlet Air Chilling and Heating System

Each CTG will be provided with an inlet air chilling system for summertime power augmentation and an inlet air heating system for anti-icing protection during the winter. The chilling system will use mechanical chillers with associated packaged cooling towers. The chilled water loop will be a closed piping system and use a solution of 25 percent propylene glycol for freeze protection. Each CTG chiller will be rated at approximately 1,800 tons of refrigeration. The chillers will use either R123 or R134a, which are considered CFC-free refrigerants.

The CTG inlet air heating system for winter anti-icing protection is composed of a self-contained heating system using waste heat from the turbine compartment ventilation system.

6.2.2.6 Demineralized Water Treatment System

The plant will be provided with a complete demineralized water treatment system designed to provide demineralized water for CTG NO_x and SPRINT injection. The source of makeup water for the plant process system will be non-potable water from the City of Ripon.

It is anticipated that the following equipment will be required as part of the demineralized water treatment plant:

- Filtration upstream of the reverse osmosis (RO) system
- RO system
- Electro deionization (EDI) system to produce the demineralized-quality water
- Raw water storage tank
- Demineralized water storage tank
- Anti scalant chemical injection upstream of RO equipment
- Sodium bisulfite chemical injection upstream of RO equipment
- Acid/caustic chemical injection upstream of RO equipment

The raw water storage tank will have a capacity of approximately 400,000 gallons and will allow for 24 hours of plant operation in the event that the City's non-potable water supply system is out of service. The demineralized water storage tank will have a capacity of approximately 160,000 gallons and will also allow for 24 hours of plant operation in the event the demineralized water treatment plant is out of service.

6.2.2.7 CTG Lube Oil Cooling Water System

The CTG lube oil cooling water system will use a portion of chiller cooling tower water to remove equipment-generated heat from combustion turbine lube oil coolers and combustion turbine generator lube oil coolers.

6.2.2.8 Fuel Gas System

Natural gas will be delivered to the plant metering station at a normal pressure of 200 to 400 psig. The fuel gas system will be designed to deliver and condition the fuel gas to the combustion turbines at the required flow, pressure, and quality over the entire plant operating range and over the full range of expected gas supply pressures. The LM6000 CTGs require a fuel pressure of approximately 675 psig. Therefore, the plant will be provided with three 50 percent gas compressors. Two gas compressors will be required to operate with the third compressor provided as a standby unit. The gas compressor system equipment will be air-cooled.

6.2.2.9 Fire Protection System

The fire protection system will be designed to provide personnel safety and plant protection through prompt detection, alarm, and suppression of a fire. The system will be designed in accordance with all applicable NFPA codes and standards and City regulations and will include the following elements.

Water Distribution System

The main source of water for the plant fire protection system will be City potable water. Redundant taps off of the City potable water system in the street will be provided for water supply reliability. Onsite fire pumps are not necessary on this project as confirmed by the local fire department. A plant fire loop will supply water around the power block area, feeding plant hydrants, sprinkler, and water deluge systems.

Isolation valves will be provided at key locations of the fire loop to allow isolation of leaks and breaks and maintain system functionality at all times.

Fire Protection and Detection

City-approved fire hydrants will be located throughout the plant near service roads. The maximum distance between hydrants shall be in accordance with local fire department requirements.

Automatic, pre-action type sprinkler systems will be provided in the electrical building's electrical equipment rooms. Wet pipe sprinkler systems will be used in office areas and warehouse storage areas. A self-contained carbon dioxide (CO_2) fire detection and protection system will be provided for the each combustion turbine enclosure. Automatic deluge systems activated by heat detectors will be provided for the generator lube oil skids. Portable fire extinguishers will be provided within buildings and at key locations throughout the plant.

Fire Alarm Panel

A fire alarm panel, located in the control room, will provide visual indication and audible alarm of any fire detected in the plant, including a fire in the combustion turbine enclosures, fire water flow to any sprinkler system, and deluge system activation. System supervisory and trouble status alarms shall be provided through the plant control system.

6.2.2.10 Service and Potable Water System

The service water system will be designed to supply water for plant services such as floor and equipment wash-down and for miscellaneous uses. The system will consist of a main header with branches to feed utility stations conveniently located throughout the plant.

The potable water system will be designed to supply water for plant buildings and for emergency eye-wash and safety showers located wherever hazardous chemicals are stored or handled. Emergency safety shower and eyewash stations will use tempered water in accordance with OSHA recommendations.

6.2.2.11 Service and Instrument Air System

The service and instrument air system will consist of two 100-percent-capacity, air-cooled, oil-free air compressors that will satisfy all instrument and service air requirements for the plant. The air compressors will discharge into a single air receiver that will serve both the service and the instrument air systems.

The service and instrument air compressor system will include dual air filters and redundant, heatless, desiccant-type air dryers. Both instrument air and service air will be dry and oil-free. The instrument air system will feed all the plant pneumatic control devices including the combustion turbines. The service air system will feed all utility stations throughout the plant.

To increase the reliability of the instrument air system, provisions will be included to interrupt the service air supply upon a system low-pressure signal.

6.2.2.12 Wastewater System

The wastewater system for the plant will be designed to collect, process, and discharge plant process wastewater from the following sources:

- Water treatment plant reverse osmosis system reject water
- Chiller system cooling tower blowdown
- Miscellaneous plant containment area drains
- Miscellaneous plant drains

The plant process wastewater will basically consist of concentrated City non-potable water as the cooling tower blowdown and RO reject water concentrates these wastewater streams. The expected total dissolved solids (TDS) level in the process wastewater prior to treatment is approximately 1,600 ppm TDS. The City has indicated that the final process wastewater stream from the plant will need to have the TDS levels lowered to approximately 800 to

900 ppm. Therefore, the plant design will include a lime-softening system designed to reduce the final wastewater stream TDS levels. The lime-softening system process equipment will include the following major equipment:

- 35,000-pound dry-lime bulk storage silo
- Lime slaking and feed system
- Solids contact clarifier
- Sulfuric acid feed system for effluent pH control
- Solids thickener
- Polymer feed system for enhanced coagulation
- Filter press
- Pumps, piping, instrumentation, and controls

The wastewater treatment system to lower the TDS levels uses a final filter press process to dewater the collected solids. The end product is a damp filter cake material that will be disposed of in a suitable landfill by an approved means.

The plant equipment drain system will consist of an underground piping network that will collect various plant drains. Drains that could potentially be contaminated with oil or grease will be directed to a corrugated plate interceptor- (CPI) type high-efficient oil/water separator prior to draining into the plant wastewater sump. The discharge from the oil/water separator will be designed to ensure the oil content is less than 10 ppm. All plant final wastewater will be directed to a plant wastewater sump. The wastewater sump will contain two 100-percent-capacity sump pumps designed to discharge the final wastewater flow to the City sanitary sewer system.

6.2.2.13 CTG Chiller Cooling Tower Chemical Feed System

The chiller cooling tower chemical feed system will be designed to inject controlled amounts of water treatment chemicals into the water system to control biological growth and to achieve optimum water chemistry, maintain system performance, and prolong equipment life. The system is composed of the following subsystems:

Bromine Feed System
Bromine will be added to control biological growth in the cooling tower.

Acid Feed System
Sulfuric acid will be added to control pH.

Dispersant Feed System
A dispersant chemical will be added to control scale formation.

Phosphate Feed System
Phosphate will be added to control corrosion.

Each chemical feed subsystem will consist of a small chemical storage ‘port-a feed’ tank and positive displacement metering pumps. The chemical feed systems will be ‘neat-feed’ type with no manual mixing or day tanks required.

6.2.2.14 Heating, Ventilating, and Air-Conditioning Systems

The electrical building will include the plant control room, electrical switchgear room, electronics room, battery room, and office spaces. The electrical building will be provided with Heating, Ventilating, and Air-Conditioning Systems (HVAC) systems as necessary for equipment protection and personnel comfort. The water treatment building will be provided with heating and ventilation systems only.

6.2.2.15 Piping

Piping Codes and Standards

All process piping will be designed and constructed in accordance with the ANSI B31.1 Power Piping Code. Fire protection piping will be designed, constructed, and installed in accordance with applicable National Fire Protection Association (NFPA) standards.

Piping Material and Design

Piping materials will be selected on the basis of suitability with the fluids being handled and for the complete range of operating pressures and temperatures expected.

The minimum pressure rating for process piping systems will be ANSI Class 150. Joints for piping 2 inches and smaller will be socket-weld, and joints for 2.5 inches and larger will be butt-weld. Flanged joints will only be used where required to match equipment, control valves, and instrumentation, and to join piping of dissimilar materials or where required for disassembly. Threaded joints will not be used except to match equipment or in galvanized piping such as fire sprinklers.

Instrument air piping and tubing will be stainless steel. Service air piping will be carbon steel.

Non-metallic piping systems will be used where possible for underground portions of low pressure, low-temperature systems such as plant drains, service and potable water systems, cooling water, and fire protection system. Non-metallic piping used for fire protection service will be listed by Underwriters Laboratories (UL) and/or approved by the Fire Marshal (FM). Underground metallic piping will be suitably protected from corrosion by coating and wrapping and through the use of a passive-type cathodic protection system.

Piping Insulation

Thermal insulation of piping systems for energy conservation will be provided where necessary.

Insulation for personnel protection will meet applicable OSHA requirements for maximum exterior casing temperatures and will be specified for all equipment within personnel access or reach that is not insulated for energy conservation. Maximum temperature of surfaces will not exceed 140°F.

Electric heat tracing will be specified for piping systems or portions of piping systems 2-inches nominal pipe size and smaller that are exposed to outdoor conditions and could experience loss of service due to freezing, such as:

- Non-drainable small bore water piping
- Small bore water piping that is not in service during normal plant operation
- Instrument-sensing lines

Piping containing glycol/water solution for freeze protection will not be heat traced.

Pipe Supports
Piping design and pipe supports will be designed in accordance with the requirements of ANSI B31.1. Supporting elements will be capable of carrying the sum of all concurrently acting loads such as: pipe and fluid weight, operating loads, wind, seismic, etc., and allow pipe thermal expansion and contraction without causing overstress.

6.2.2.16 Valves

Codes and Standards
Valves will meet the requirements of ANSI B31.1 Power Piping Code. Fire protection valves will be UL-listed and/or FM-approved for fire protection service.

Valve Materials and Design
Valve selection will be based on the required function, material, and pressure rating of the piping system, and the size of the pipe and the piping fluid. Valve type will be selected based on operational and maintenance considerations as well as good engineering practice.

6.3 Instrumentation and Controls

6.3.1 Control System Design

The plant instrumentation and control system will be designed to allow the operators to achieve safe and reliable operation of the power plant. Major equipment monitoring, control, and operation will be provided from the control room using plant control system (PCS) control consoles and the CTG Human Machine Interfaces (HMIs). The integration of the various plant systems will be accomplished by the PCS. The PCS will be used for supervisory control and monitoring of major plant components and package systems, such as the combustion turbine generator, and it will be used for direct control of SCR loops and other balance-of-plant equipment and processes.

A full-function operator workstation is located at the MID Woodland Generation Station (WGS) which is manned 24-7. From this HMI, monitoring of the CTGs and full control and monitoring of the balance-of-plant equipment will be possible. WGS is approximately 8.5 miles from MEGS. Limited control (start and shutdown) capability and system monitoring (plant MW, MVAR output, etc.) will be possible through a remote terminal unit interface with the MID central dispatch. Major system components are described in the following sections.

6.3.1.1 Combustion Turbine Generator Controls

The CTG will be provided complete with a vendor-packaged and integrated control system that provides for automatic and manual start-up, synchronizing, loading and unloading, protection, and shutdown of the CTG system from the CTG HMI in the control room.

The CTG control system will accept contact inputs for start, stop, and other operating commands from the PCS. In addition, a Modbus communications link will provide CTG process signals and alarms to the PCS for purposes of monitoring, trending, and archiving critical variables.

6.3.1.2 Plant Control System

The PCS is a programmable logic controller (PLC)-based control system providing analog and sequential logic control, advanced control computations, data acquisition, operator interface, and computer interface capabilities. The PCS will provide overall control and operator interface to the generating facility. The PCS will incorporate state-of-the-art digital technology in a redundant PLC-based system. It will consist of a real-time functionally distributed computer control system equipped with adequate memory, input/output (I/O) hardware, termination cabinets, redundant data highway, operator interface consoles, engineering workstation, and peripherals such as printers, mass storage, etc.

Features of the PCS will include redundancy of control processors, power supplies, operator stations, printers, and communications. In addition to its control capabilities, the system will include features required for historical data recording, data processing, and report generation.

The PCS includes the following additional features:

- Supervisory interface and monitoring of the combustion turbine generator with direct control of all SCR loops, auxiliary loads, and balance of plant motor loads and process loops.
- Visual and audible alarms for abnormal events in a display hierarchy based on criticality of the event, from field instrumentation measurements or software-generated calculations of plant systems, processes, or equipment. Capability to prioritize alarms will be included. Alarms shall be time tagged to the nearest second.
- Plant operating, maintenance, and historical logs automatically as programmed or based on operator demand.
- All information within the control system will be available on the operator CRTs. Information is transmitted between the PCS control nodes or drops via dual redundant data highways. The highways will use an appropriate medium (coaxial cable, fiber optics, etc.). Both highways are active at all times, providing for a “hot backup” in the event of single failure.
- Each of the operator control stations will be capable of performing (at a minimum) the following functions:
  - Configuring and tuning all modules in the system. Storage of this information shall be on a separate medium (magnetic floppy disk, hard disk, or CD-ROM).
  - Monitoring the value or status of at least 2,000 system points (soft and hard).
  - Auto/manual transfer, set point adjustments, and manual operation of outputs.
  - Alarm indicators with alarm overview and alarm summary.

– Interactive graphic displays.

– Control processor will be capable of performing both analog (basic and advanced) and digital control functions. Process controllers will be configured as one-to-one redundant with automatic transfer to the backup controller in case of controller failure. Each processor will be capable of being programmed and modified online. In general, all process information will be available to the operator within one second of real time. Individual controllers shall not be loaded beyond 65 percent of full processing capability, including memory allocation.

6.3.1.3 Plant Instrumentation

Plant instrumentation and control equipment will be of a proven design and chosen to ensure a high-level of reliability. When redundant controls are required, completely separate devices with individual sensing taps and isolation capability will be provided.

Transmitters

Electronic "smart" transmitters will be used and have a minimum accuracy of ± 0.1 percent of calibrated span.

Pressure-sensing devices will be provided with adequate valving and test connections for in-line calibration. Manifold valves will be used where practical. These manifolds will contain instrument, test, and where required, equalizing valves. Instrument tubing will be sloped and freeze-protected as required and shown on instrument installation details. All transmitter manifolds shall include calibration taps.

Flow transmitters, in general, will be differential pressure type with square root extraction performed in the DCS.

Primary Flow Elements

Primary flow elements include the following:

- Flow nozzle meter runs will be used where highly accurate flow measurements are required.
- Removable type orifice plates or multiple port pitot tubes (annubar type) will be provided for other liquid or steam process flow measurements as appropriate.
- Thermal mass flow sensors used for gas or air monitoring where appropriate.
- Specialty sensors/transmitters such as vortex shedding, magnetic flow meters, turbine meters, or special stack flow sensors will be used for special application measurements as required.

Thermocouples and Resistance Temperature Detectors

All process thermocouples and resistance temperature detectors (RTDs) are of the 3-wire platinum type with normal resistance of 100 ohms at 0°C.

For high-temperature and metal-temperature measurements, thermocouples would be used. Thermocouples, in general, would be type J, K or E as appropriate, with dual elements.

Thermowells

Temperature sensors will be equipped with the thermowells made of one piece, solid-bored Type 316 stainless steel of stepless tapered design.

Local Indicators

Thermometers will be the bimetallic adjustable angle type with minimum 4.5-inch dials and ±1 percent accuracy. Thermometers for remote mounting will be gas-actuated with stainless steel armored capillary tubing of the length required for installation. Thermowells are furnished for all thermometer bulbs.

Pressure gauges will be the bourdon tube type with solid front cases, 4.5-inch dials, stainless steel movements, and nylon bearings. Gauges will have 0.5-inch NPT bottom connections and will be provided with pigtail siphons for steam service, snubbers for pulsating flow, and diaphragm seals for corrosive or severe service. Liquid-filled gauges will be used where there is pipeline vibration.

Tubular gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. Mica shield will be used with transparent gauges on steam/condensate service. All gauge glasses will be equipped with gauge valves including a safety ball check.

Temperature, Pressure, Level, and Flow Switches

Temperature, level, pressure, and flow switches will generally have two Form C contacts and will be equipped with screw-type terminal connections for field wiring. Switch set points will be adjustable with a calibrated scale. Contacts will be snap-acting type. Switch enclosures will be NEMA 4 for non-hazardous locations, and NEMA 7 or 9 for hazardous locations.

Control Valves

Control valves used in modulating service will have normal operational range from 30 to 80 percent. Minimum control valve body size will not be less than 50 percent of the upstream pipe size. In general, control valve leakage class will be minimum ANSI B16.104 Class IV. Each control valve will be provided with accessories such as filter regulators, solenoid valves, 4-20 mA position transducers and limit switches as applicable. Control valves will be provided with valve position feedback transducers (4-20 mA).

Pneumatic Operators

Pneumatic piston actuators or diaphragm operators will be provided for air-operated valves. Air operators will function properly on plant air supplied between 80 and 125 psig fluctuating pressure. Air filter-regulators will be provided for each operator.

Instrument Piping and Tubing

Instrument piping and tubing will be installed in accordance with applicable installation details and routed in an orderly manner, grouping together lines wherever practical.

Vents, drains, or traps will be provided at high or low points on impulse lines to vent air or entrained solids which may settle out.

Minimum process piping or tubing size will be 0.5-inch except for connections at instruments, which will be manufacturer’s standard.

6.3.1.4 Programmable Logic Controllers

When programmable logic controllers (PLCs) are provided as part of the plant or packaged control systems, controller memories will be battery-protected or be of the non-volatile type. Vendors will provide ladder diagram type documentation for all programmable controller logic. A terminal unit will be provided for entering program changes, storing programs, and loading programs directly into the programmable controller memory. All PLCs supplied shall have PC interface and application software to provide data and program retrieval and manipulation. This PC interface may also be used in lieu of a separate terminal unit for programming the PLC.

6.3.1.5 Control Room

The plant control room will be located in the electrical building. It will contain the CTG and the PCS HMIs, the CTG control panels, the plant fire alarm panel, closed-circuit television (CCTV) control stations and recording equipment, the CEMS DAS (HMI), and other communications and plant monitoring equipment.

6.4 Electrical

6.4.1 General

This section covers criteria for the design of the electrical auxiliary power systems used in conjunction with the combustion turbine generators and support equipment to be installed at MEGS and integrated into the MID electrical network.

6.4.1.1 Design Considerations

The MEGS plant includes two natural gas fired aero-turbines, each driving a 13.8-kV synchronous generator.

The output of each generator is connected to the MID 69-kV distribution network through a two-winding 13.8 to 69-kV generator step-up (GSU) transformer.

Power for the station electrical auxiliary loads is provided through two 13.8 to 4.16-kV auxiliary transformers, each connected at the output of one of the generators. Each auxiliary transformer will be energized from the 69-kV bus through its respective GSU transformer when the generator circuit breaker is open during start-up and periods when unit is not operating. Each of the auxiliary transformers is sized to accommodate all auxiliary system loads associated with the entire station, including common station loads. During normal operation, the auxiliary system loads pertaining to one turbine are carried by the auxiliary transformer connected to its respective turbine.

Each auxiliary transformer is connected to one section of a double-ended 4.16-kV switchgear with a normally open bus-tie breaker. Automatic (residual voltage activated) transfer to a live bus section is accomplished in response to loss of voltage on either bus. Synchronized, momentary parallel retransfer of a bus section to the normal source is by operator action only.

For the basic configuration of the plant auxiliary system, see the MEGS One-Line Diagram—Drawing E2.1.

The complete electrical system is economically designed for reliability of service, safety of personnel and equipment, ease of maintenance and operation, minimum power losses, and mechanical protection. The electrical system includes provision for the addition of future loads, and maximum interchangeability of equipment.

Voltage insulation levels, interrupting and continuous current capacities, circuit protection, and mechanical strengths of all equipment shall be selected and coordinated in accordance with good practice and the requirements of the documents or organizations listed in Section 6.1.3.

Electrical system protective devices (relays, fuses, circuit breakers, etc.) shall be selected and coordinated to ensure that the circuit protective device nearest the point of fault (or high overcurrent) will open first (selective tripping) to minimize equipment damage and disturbances to the remainder of the system.

Selection of electrical equipment, and the installations for its use in hazardous areas (if any), shall be in accordance with requirements of NEC Article 500, other applicable related industry standards, and local fire department regulations.

All electrical equipment used in the design of MEGS shall be in accordance with the appropriate IEEE, NEMA, ICEA, ANSI, NFPA and other applicable industry standards and MID standards.

6.4.1.2 Major Electrical Equipment

Major electrical equipment items include:

- Two 13.8 to 69-kV GSU transformers
- 15-kV cable bus duct connections from the output terminals of the generators to the metal-clad 13.8-kV switchgear, and from the 13.8-kV switchgear to the GSU transformers
- 13.8-kV outdoor aisle-type metal-clad switchgear
- Two 13.8 to 4.16-kV auxiliary transformers
- 4.16-kV indoor metal-clad double-ended switchgear
- Two 4.16 to 0.48-kV station service transformers
- 600-volt metal-enclosed non-segregated-phase bus duct
- 480-volt indoor metal-enclosed double-ended switchgear
- Four 480-volt motor control centers
- 120-Vac uninterruptible power supply (UPS) system for the plant control system (PCS)
- 125-Vdc power distribution system including batteries and battery chargers to supply dc power to the switchgear controls and the 120-Vac UPS

Generator Step-Up Transformers

Two generator step-up transformers will be provided, one for the output of each turbine generator.

The GSU transformers will be three-phase, oil-filled, rated 39/52/65 MVA @ 65°C rise, with OA/FA/FA cooling. The low voltage winding is rated 13.8 kV, 110 kV BIL, delta connected. The high voltage winding is rated 69 kV, 350 kV BIL, wye connected with solidly grounded, 110 kV BIL neutral, with five 2.5 percent full capacity, no load taps around 69 kV (nominal, ±2.5 percent, ±5.0 percent).

Cable Bus

Cable bus, rated 15 kV, will be run from each generator to its associated circuit breaker and from the breaker to its GSU transformer. The bus will be enclosed and run overhead. It will consist of several copper conductors per phase of 15-kV, shielded, 90°C temperature rise, single-conductor cable. The cable bus for the combustion turbine generators will be rated 2700A.

Auxiliary Transformers

Two 13.8 to 4.16-kV auxiliary transformers provide power to the 4.16-kV system. The transformers are located outdoors with the low voltage windings connected to one section of the 4.16-kV switchgear via 5-kV, shielded, single-conductor cable with 133 percent insulation, run in an underground conduit duct bank. The transformers will be three-phase, oil-filled, rated 5000 kVA, OA, 55 °C rise; 6250 kVA, FA, 55 °C rise; 7000 kVA, FA, 65 °C rise. The 5000 kVA OA rating of the transformer corresponds to the total of the auxiliary system loads. The high voltage winding is delta-connected, rated 13.8 kV, 110 kV BIL, with five 2.5 percent full capacity, no load taps around 13.8 kV (nominal, ±2.5 percent, ±5.0 percent). The low voltage winding is rated 4.16 kV, 75 kV BIL, wye-connected, with the 75 kV BIL neutral point grounded through a top-mounted stainless steel resistor to provide medium resistance grounding (400 amps).

The high-voltage windings are connected to the 13.8-kV combustion turbine generator metal-clad switchgear via 15-kV, shielded, single-conductor cable with 133 percent insulation, run in an underground conduit duct bank.

13.8-kV Switchgear

Outdoor, metal-clad 13.8 kV (15 kV Class) switchgear in a NEMA 3R aisle-type enclosure, including drawout-type vacuum circuit breakers, rated 1500 MVA symmetrical interrupting capacity, shall be provided to accept power from the generators and interconnect with the GSU and auxiliary transformers. Each 13.8 kV or 4.16 kV breaker may be tripped manually from the switchgear location under emergency conditions.

A cable tap in the switchgear is provided as the service point for the feed to the auxiliary transformers. Solid-state multi-function relays are provided in the switchgear for GSU transformer protection and to protect the feeder cable to the auxiliary transformer.

4.16-kV Switchgear

Indoor, double-ended, metal-clad 4.16-kV (5-kV class) switchgear in a NEMA 1 enclosure, including drawout type vacuum circuit breakers rated 350 MVA symmetrical interrupting capacity, shall be provided, fed from the 4.16-kV winding of both auxiliary transformers. Two buses (sections) with interconnecting tie-breaker are provided for feeding motor and station service transformer loads.

Each auxiliary transformer connects to one of two buses of the 4.16-kV switchgear. The buses and incoming circuit breakers of both 4.16-kV switchgear sections are sized to handle the total auxiliary load of the plant. The two buses are connected by a normally open tie-breaker. The tie-breaker may be used as a spare for either incoming main breaker or any of the feeder breakers.

Manual operating control of all breakers is from the control room. In the event of a power loss on one of the two 4.16-kV buses, automatic transfer to the other bus occurs only after the bus voltage has been reduced to 20 to 25 percent of rated value (residual voltage transfer). Synchronized, momentary parallel retransfer to the normal source is by operator action only. Manual control, in the test position only, is from the location of the switchgear. The 4.16-kV switchgear is located in the switchgear room of the electrical building. Each 4.16-kV breaker may be tripped manually from the switchgear location under emergency conditions.

Station Service Transformers

Two 4.16-0.48-kV station service transformers provide power to the 480-volt system. The transformers are located outdoors and each is connected to one section of the 480-volt double-ended switchgear via 3200A, non-segregated bus duct routed overhead. The transformers are three-phase, oil-filled, rated 2000kVA, OA, 55° C rise, 2300 kVA, FA, 55° C rise, 2576 kVA, FA, 65° C rise, to supply the total 480-volt system load on both switchgear sections with the tie-breaker closed.

480-volt Switchgear

Each station service transformer connects to one of two buses of the 480-volt double-ended switchgear. A normally open tie-breaker connects the two buses. The 480-volt switchgear serves the four motor control centers and the two 480-volt panel boards. The switchgear consists of drawout, metal-enclosed circuit breakers, 65 kAIC. Each circuit breaker is provided with integral solid-state trip units to provide long-time, short-time and ground-fault protection.

Motor Control Centers

There will be four motor control centers, designated CTG1 (MCC E121), CTG2 (MCC E221), BOP1 (MCC E005), and BOP2 (MCC E006). They will be free-standing, NEMA 1 gasketed structures with front-only construction, consisting of molded-case circuit breakers and combination MCP (Motor Circuit Protector) breakers and motor starters 1/2 hp through 200 hp. Controllers are arranged for full voltage starting of motors automatically through the CTG control systems or through the PCS. The MCCs will be equipped with 20 percent spare combination starters in sizes to accommodate motors through 25 hp. The motor control centers are connected to the 480-volt switchgear by overhead cable in cable tray. The 480-volt MCCs will be rated 65 kAIC.

6.4.1.3 Area Classification

Hazardous Areas

Hazardous area classifications (if any) will be in accordance with the National Electrical Code, Article 500. Classifications in the fuel gas area will follow the recommendations of the American Petroleum Institute (API) Standard No. RP-500A and of the local fire department. All equipment will be suitable for the area in which it is installed. Hazardous areas (if applicable) will be defined on plant area classification drawings.

Non-Hazardous Locations

The switchgear room (and 125-volt battery area if sealed cell batteries are used) are classified as non-hazardous locations. The interface areas between area classifications (if applicable) are defined on area classification drawings.

6.4.2 Systems

6.4.2.1 Protection System

Protective equipment shall be installed to provide protection against electrical faults and abnormal system conditions. The protection schemes are designed and coordinated so that the protective device nearest to the fault operates first, with backup being provided by the next upstream protective device in the system and subsequent relay stages. Selectivity applies in phase-to-phase and three-phase, as well as to ground faults.

In the event of a fault in a generator, in which its protective zone extends from the neutral end of the windings to the load side of generator breaker 52-1G1 (52-2G1), generator breaker 52-1G1 (52-2G1) would trip and initiate shutdown of the affected turbine generator. The 69-kV breaker 152-1 (152-2) will remain closed so that the plant auxiliaries remain energized for restart.

In the event of a malfunction of breaker 52-1G1 (52-2G1), breaker failure relay 50BF-1 (50BF-2) would trip 69-kV breaker 152-1 (152-2) and auxiliary transformer breaker 52-11 (52-21) to isolate the fault.

In the event of a fault in the main step-up transformer T1-1 (T2-1), generator breaker 52-1G1 (52-2G1), 69-kV breaker 152-1 (152-2) and auxiliary transformer breaker 52-11 (52-21) would trip to isolate the fault. The following protective relays in Table 6-3 are also provided for protection of each generator.

In addition, the generator automatic voltage regulator includes over- and under-excitation limitation circuitry.

Plant startup is initiated through closure of 69-kV breaker 152-1 (152-2) to energize the auxiliary power system from the 69-kV system. Synchronization of CTG1 (CTG2) is accomplished across breaker 52-1G1 (52-2G1). There will be an interlock in the close circuit of 69-kV breaker 152-1 (152-2) to prevent closure in the event CTG1 (CTG2) breaker 52-1G1 (52-2G1) is closed.

TABLE 6-3
Generator Protective Relays

15/25	Speed Matching Auto-Synchronizer
24	Over-Excitation (Volts per Hertz)
25	Synchro-Check
27	Phase Undervoltage
32	Anti-Motoring (Reverse Power)
40	Field Failure (Loss of Excitation)
46	Negative Phase Sequence
49G	Stator Over Temperature
50/27	Inadvertent Energization
50BF	Breaker Failure
51V	Inverse Time Overcurrent (Voltage Restraint)
59	Phase Overvoltage
59N	Neutral Ground (Neutral Overvoltage)
60	Voltage Balance (Fuse Loss)
64G	Field Ground (Part of Voltage Regulator Circuitry)
78	Out-of-Step
81O/U	Over-Under Frequency
87G	Stator Differential

The GSU transformers are protected from lightning and switching surges by station type, metal oxide station-class surge arresters on the high voltage terminals. For other problems, these transformers, as well as the auxiliary transformers, are each protected by a pair of microprocessor relays consisting of a Multilin SR745® for primary protection and a Multilin SR750® for backup protection. The Multilin SR745® provides the functions of a differential relay, phase and ground, instantaneous and time overcurrent relays, negative sequence, overtemperature, overvoltage and over and underfrequency relays. The transformer protective zone extends from the generator side of generator breaker 52-1G1 (52-2G1) and the generator end of the feeder to auxiliary transformer T1-2 (T2-2) to the line side bushings of the 69-kV circuit breakers.

The Multilin SR750® provides the functions of phase and ground, instantaneous and time overcurrent relays, negative phase sequence, undervoltage and underfrequency relays.

The station service transformers are provided with a Multilin SR745® only; backup protection being furnished by the overcurrent relay (Multilin SR735®) on each of the transformer 4.16-kV feeders.

All motors are protected against faults and overloads. Medium voltage motors are protected by fuses for high level faults and either a Multilin SR469® or Multilin SR269 Plus® relay for low level faults and overloads. For motors fed from the 480-volt motor control center, overload settings shall be in accordance with guidance of the NEC (approximately 1.15 times full load current). Certain critical motor operated valves are not provided with overload protection in the direction of travel required for safe plant shutdown.

6.4.2.2 Grounding System

The station grounding system shall consist of a network of buried, bare, stranded copper cables installed around the perimeter of the station site, the generators, the GSU, auxiliary, and station service transformers, the outdoor metalclad switchgear and buildings associated with the plant. The grounding network shall consist of the underground grounding grid, grounding electrodes, equipment-grounding conductors, crushed rock at grade level and above-grade equipment and structure-grounding connections. A separate, isolated, insulated, high-quality grounding system shall be provided at the control room for instruments and computers only. Equipment located remotely from the main grounding network shall be grounded by means of individual grounding conductors and grounding electrodes.

IEEE Standard 80 will be followed where applicable. Any equipment not directly bolted to a grounded supporting structure is connected to the grounding system.

Grounding for components of the station:

- The star point (neutral) of the 69-kV wye connected windings of the GSU transformers shall be solidly grounded.
- The generator neutral point shall be high-resistance grounded through a distribution type transformer with a resistance-loaded secondary winding. Ground fault current shall be less than 10 amperes.
- The star point (neutral) of the low voltage wye connected windings of the 13.8-kV to 4.16-kV auxiliary transformers shall each be grounded through a separate grounding resistor. Ground fault current shall be limited to 400 amperes to allow fast operating time of protective relays.
- The 4.16-kV to 480-volt station service transformers shall be solidly grounded at the star point (neutral) of the wye connected secondary windings.
- The star point (neutral) of each wye connected winding of lighting and low voltage power transformers shall be solidly grounded.

A separate insulated, isolated instrument ground bus shall be provided and used only for connecting instrument ground terminals and instrument cable shielding. The instrument grounds of individual panels will be connected to a central point using insulated cable to form the instrument ground bus. The connections shall be made radially and looping shall not be permitted. The instrument ground bus shall be solidly connected to the main plant grounding system at one point only. The rest of the instrument ground bus is isolated from ground. The shields of instrument cables shall be grounded at one end only. Thermocouple cable shields shall be grounded at the thermocouple end. All other cable shields shall be grounded at the control room end.

6.4.2.3 Cathodic Protection

Passive type cathodic protection systems will be used where practical for underground metallic piping or equipment. Insulating flanges will be installed to electrically isolate underground pipes from above-grade grounded piping and structures. Non-metallic piping will be used where possible for the underground piping system to minimize the need for cathodic protection systems.

6.4.2.4 DC and UPS Systems

The station 125-volt dc and 120 Vac UPS systems shall be sized to accommodate the requirements of all balance-of-plant systems supporting the generators. The turbine generators are equipped with a 24-volt battery system for their own control and fire protection systems. The station 125-volt batteries furnished under these design criteria are sized to accommodate all other normal and emergency dc loads including the 120 Vac UPS. The station battery and the batteries for the turbine generators may be installed in a separate battery room. Two battery eliminator type chargers are provided for the station 125-volt batteries.

The station 125 Vdc and 120 Vac UPS systems shall consist of the following items located in the air conditioned electrical building areas: a solid state inverter, an automatic static transfer switch, two battery chargers, 125 Vdc switchboard/distribution panel, 120 Vac UPS bypass transformer (regulated type), and 120 Vac UPS distribution panel. These systems shall supply all normal power loads and emergency power necessary for orderly shutdown of the units and shall maintain emergency power to the control system for a minimum of sixty minutes. The 125 Vdc and 120 Vac UPS systems shall also supply power for instruments and switchgear control. Emergency lighting units are not fed from the station battery.

The 125 Vdc system operates ungrounded. Two-pole circuit breakers or fuses in each pole shall be used throughout. Ground detectors and alarms shall be provided.

6.4.2.5 Paging and Communication System

An intra-plant telephone and public address (PA) system shall be provided for the station and shall tie into the local telephone service. The new speakers and phones will be installed at selected locations throughout the plant. Outdoor units will have weatherproof, sound reduction housings.

Telephone cabling, pull boxes, and associated conduit runs will be provided from the control room to phones at selected locations, and a PBX and telephone backboard shall be installed in the electrical building with a trunk line to the point of telephone service interconnection with the local telephone company.

6.4.2.6 Closed-Circuit Television System

A CCTV system shall be provided to monitor the station main entrance gate and strategic process locations. Video control, monitors, and recording shall be provided in the control room.

6.4.2.7 Fire Detection and Protection

Fire detection and alarm is part of the Fire Protection system, and is designed to provide detection, alarm, and monitoring. Ionization detectors will be provided. The main fire control panel will be located in the control room to monitor all “alarm” and “trouble” conditions that may occur. (see Fire Protection System, Section 6.2.2.9 for details). Indication of any alarm or trouble will be transmitted to MID’s offsite control center via an RTU and to the PCS. In the event of a fire in the control room or switchgear room, where pre-action water sprinkler systems are installed, activation of the sprinkler water flow will be preceded by a cutoff of all electric power in the room. This amounts to a unit trip.

6.4.2.8 MID-Stockton Station Interconnection

MID will furnish all the equipment and perform all modification and expansion work in the 69-kV Stockton switchyard. MID will also install and terminate two 69-kV aerial circuits and a fiber optic cable from the Stockton Switchyard to MEGS (overhead lines on wooden poles).

At the station, the 69-kV hardware will include the takeoff structure, two 69-kV circuit breakers with manually operated, vertical-air-break, no-load disconnect switches on both sides, and aerial cable between the structure, switches, circuit breakers and the main transformers. Supply and installation of this hardware will be performed by the contractor.

6.4.3 Equipment

6.4.3.1 Switchgear, MCC and Battery Locations

The 13.8-kV, 4.16-kV, and 480-volt switchgear and the motor control centers shall be centrally located with respect to the loads served. Each 13.8-kV breaker will be located outdoors adjacent to its associated generator. The remaining switchgear and the motor control centers will be located in the electrical building. Areas allocated for switchgear and the motor control centers shall be sized in excess of the initial installation requirements. Sufficient space shall be provided for future expansion and maintenance work, including the removal and transportation of circuit breakers. Battery type will be determined later.

If sealed cell battery modules are used, including those furnished with the combustion turbine generators, the battery area does not require a deluge shower. However, an eyewash station is required. The battery area will not require isolation from the switchgear room nor special ventilation.

If wet cell nickel cadmium battery modules are used, the battery area will be isolated from other electrical equipment and adequately ventilated according to equipment requirements and local conditions. Deluge shower and eyewash facilities will also be provided.

Adequate fire detection and extinguishing equipment shall be installed in all equipment areas and made easily accessible.

6.4.3.2 Maintenance Control Stations

In general, process actuation and control devices such as motors, valves, etc., associated with the combustion turbine generator unit shall be operated from the plant control room. Local bypass of turbine and generator controls shall not be permitted. Balance of plant motors and motor operated valves will have locally mounted control stations as described below to facilitate maintenance.

Each motor shall be provided with a “REMOTE-OFF-ON” manual switch lockable in the “REMOTE” and “OFF” positions. The switch shall spring return from the “ON” to the “OFF” position.

Each motor-operated valve shall be provided with a “LOCAL-REMOTE” selector switch, lockable in the “REMOTE” position, and a separate spring-loaded “JOG” switch, spring-return-to-center from the “CLOSE” and “OPEN” positions.

All switches shall be keyed the same. All control stations shall be provided with suitable nameplates showing the equipment service identification.

6.4.3.3 Motors

AC Motors

AC motors shall be sized as follows:

- Motors rated 250 hp and larger shall be rated 4,000 Vac, 3 phase, 60 Hz
- Motors rated 200 hp and smaller shall be rated 460 Vac, 3 phase, 60 Hz
- Motors rated 1/3 hp or less shall be rated 115 Vac, 1 phase, 60 Hz

Motors 250 hp and larger shall be fed from the medium voltage motor controllers close-coupled to the 4.16-kV switchgear using fuse-protected vacuum type contactors. Motors rated 460 volts and 200 hp or less shall be supplied from combination full voltage starters assembled in the 480-volt motor control centers.

Motor service factors shall be as follows:

- Motors 200 hp and lower, 1.15
- Motors 250 hp and larger, 1.0

Motors shall be sized so that their rating at a service factor of 1.0 is not exceeded at any point on the operating curve of the driven equipment. Motor winding insulation shall be class F with class B temperature rise. Rotor bars and end rings of motors 250 hp and larger shall be copper. Motors for pumps shall have nominal horsepower ratings at least equal to the percentage of pump-rated break horsepower indicated in Table 6-4.

TABLE 6-4
Pump-Rated Break Horsepower

Motor Name Plate Rating	Percent of Pump Rated Break Horsepower
<25 hp	125
30-75	115
100 and over	110

Gear losses, if any, shall be added to driven equipment brake horsepower before motor driver rated horsepower is determined.

Motor winding heaters shall be provided in all motors 25 hp and larger. Motors heater power will be supplied by the motor controller or combination starter control power transformer (CPT). Motor heaters shall be operated at 120 volts, 1 phase, 60 Hz up to 1,650 watts. All heaters shall be rated at twice the operating voltage.

Motors 1,000 hp and larger shall be provided with Bently-Nevada type vibration monitors and core-balance CTs mounted in the main terminal box for motor differential protection.

Motors 250 hp and larger shall be equipped with six stator winding resistive temperature detectors (RTDs) – two per phase and two motor bearing RTDs. The RTDs shall be 100 ohm platinum type and shall be wired out to a separate motor terminal box. The RTDs will be used to map and monitor the thermal characteristics of each motor.

DC Motors

120 Vdc rated motors, if required, shall have full voltage or current limit type starting as required. DC motor enclosures shall be designed for the service and area where installed. Motor winding insulation shall be class F with class B temperature rise. DC motors will be powered from the 125 Vdc power distribution system.

6.4.3.4 Motor Controllers

General

Each motor controller shall be properly selected for short-circuit duty, continuous current, voltage level, starting current, and overload current.

Medium voltage (4,000 volts) motors shall be fed from 4.16-kV switchgear close-coupled fuse-protected 5-kV vacuum contactors.

Low voltage (460 volts) motors shall be fed from 480-volt motor-control-center-mounted combination starters.

Motor Controllers—Medium-Voltage Switchgear

Medium-voltage motor controllers shall have three electronic fuses and vacuum-type NEMA E2 contactors. Each motor controller shall be equipped with a CPT for control power. Additional contactor auxiliary contacts shall be provided for alarms, interlocks, etc.

Each medium voltage motor controller shall be equipped with a solid-state multi-function motor-protective relay current transformer for each phase and a window-type zero sequence ground current transformer.

Motor Controllers—480-Volt Motor Control Centers

Three-phase motor starters, rated 480 volts, shall be the combination type, with magnetic contactors and molded-case magnetic trip only air circuit breakers (motor circuit protectors, MCPs) for motors up to 200 hp. Circuit breaker operating handles shall be capable of being locked in the OFF position. Each combination starter shall have an adjustable electronic overload relay with an externally operated manual reset button. The overload range shall be selected according to the motor full-load amperes.

Motor Controllers—115 Volts

Motor controllers for fractional horsepower, single-phase motors shall be manual starters with built-in thermal overload protection. Each manual controller shall be located near, and in clear view of, the controlled motor.

6.4.3.5 Station Lighting

Station lighting will be designed to provide unobstructed illumination in all buildings and along all walkways, in general plant areas, on roadways, and around building perimeters. Lighting fixtures will be located to provide uniform illumination and ease of relamping and maintenance.

Outdoor lighting shall be in accordance with the CEC plant construction license. Outdoor light fixtures shall be selected, mounted, and positioned to prevent unnecessary illumination of the night sky, and to avoid light trespass, or light source visibility from adjacent properties.

High pressure sodium fixtures will be used for all outdoor areas and in the combustion turbine room. Except for the turbine room, fluorescent light fixtures will be used in indoor areas. All outdoor lighting will be controlled from a single photocell or from locally mounted switches. Outdoor lighting will be fed at 208 volts. Indoor lighting will be fed at 120 volts. Lighting wire will be rated 600 volts, type XHHW or XHHW-2.

Lighting shall achieve the following minimum maintained illumination levels:

Outdoor Areas:

General exterior area	0.5-2 Fc
Roadway and perimeter	0.5-2 Fc
Walkways, stairways and platforms	5 Fc

Indoor Areas:

CTG building	30 Fc
Switchgear room	30 Fc
Laboratory	50 Fc
Maintenance area	20 Fc

Emergency lighting will be provided in the electrical building and other areas determined to be critical to the facility. This lighting will consist of wall- or ceiling-mounted dual seal beam (battery pack) fixtures and lighted exit signs, and will be suitable for 90 minutes of operation.

Convenience outlets for 120 Vac shall be located in the process areas to be reached by a 25-foot extension cord. A minimum of six 60-A, 480-volt, 4-pole outdoor outlets shall be strategically positioned around the station.

Lighting panel boards will be used for the control of lighting, convenience receptacles, single-phase motors, and other similar loads. Lighting panels will be provided with minimum 20 ampere plug-in circuit breakers. Each panel will be provided with approximately 20 percent spare breakers. Each lighting panel will be fed from a dedicated 480-208Y/120-volt transformer.

6.4.3.6 Wire and Cable

All current-carrying power and lighting conductors will be sized in accordance with NEC ampacity tables and the following criteria, except where minimum sizes are determined otherwise. All power, control, and instrument cables shall be flame retardant and cable tray rated:

- 15-kV power cable will be class "B" coated, stranded copper, shielded, 90° C, 133 percent EPR or XLP insulation with overall thermosetting CP or CPE jacket.
- 5-kV power cable will be class "B" coated, stranded copper, shielded, 90° C, 133 percent EPR or XLP insulation with overall thermosetting CP or CPE jacket.
- 600-volt power cable will be class "B" coated, stranded, three-conductor copper with ground, 90° C, XLP or EPR insulation with overall thermosetting XLP or CSPE jacket. Individual conductors will be identified per ICEA Method 4, Table K2, complete with bare ground wire. Cables No. 4/0 AWG and above will be single-conductor.
- 600-volt control cable will be class "B" coated, stranded copper, 90° C, XLP or EPR insulation, multi-conductor, with overall thermosetting XLP or CSPE jacket. Individual conductors will be identified per ICEA Method 1, Table K2.
- 600-volt instrumentation cable will be shielded, class "B" coated, stranded copper, 90° C XLP or EPR insulation with overall thermosetting XLP or CSPE jacket.
- 600-volt thermocouple extension cable will be similar to instrumentation except conductors will be solid alloys per ANSI MC 96.1 (standard limits of error).

6.4.3.7 Cable Routing Criteria

Cable tray and exposed conduit will generally be run in internal building spaces such as the electrical building. Partial, or full, false floors below computer, communications, or control rooms may be used. Cable fill will be in accordance with NEC Article 318. Outdoor cabling will be installed in underground concrete-encased, RGS conduit duct banks between major equipment locations and the electrical building. Aboveground raceways will be used at the equipment. All raceways, including cable tray, will be installed in accordance with NEC requirements. All raceways will be separated by voltage and/or system as follows:

- DCS data highway
- Communications, video, and PA system
- Fire detection and alarm
- Low level signal (4—20 mA)
- 120 Vac and 125 Vdc Control (less than 20A)
- 480 Vac power, motor space heater power and 125 Vdc power (20A or greater)
- 4.16-kV power
- 13.8-kV power

Cables will be identified by cable number at each end of each cable. All control wires will be uniquely identified by color at point of termination.

6.4.3.8 Cable Sizing Criteria

Voltage Drop

Voltage drop criteria are as follows:

- Two-percent maximum on feeders and sub-feeders.
- Three-percent maximum on 4.16-kV feeders from switchgear to motor or transformer load.
- One-percent maximum on bus ducts, from transformer to motor control centers or switchgear.
- Three percent maximum on 480-volt feeders, from starter to motor.
- Two-percent maximum on lighting, instrumentation, and other low voltage circuits, from 120 Vac bus to distribution panels.
- Three-percent average in branch circuits, from panels to load center of circuits, with a maximum of four percent to the most distance outlet.

Ampacity

Feeder cables shall be sized based on the following multiplying factors applied to the full load current:

All motors	1.25
All transformers	1.15 (times max FA rating @ 65° C)

The following additional provisions shall also apply:

- The maximum ampacity for any cable shall depend upon the worst case in which the cable is routed (tray, conduit, duct, or direct buried). In addition to ampacity, special requirements such as voltage drop, fault current availability, and environment shall be taken into consideration in sizing of cable.
- Cable ampacities shall be in accordance with National Electrical Code Tables 83—10 and ICEA Publication P46—426.

Short-Circuit Current Criteria

The maximum short-circuit current protection and circuit breaker clearing times normally determines the minimum size cable used for a given load. For circuits with unusually long feeder lengths, voltage drop may be the determining factor.

The maximum allowable conductor temperature, after a short circuit (assuming rated conductor temperature prior to the short-circuit), can be 250° C for copper conductors insulated with ethylene propylene rubber and cross-linked polyethylene insulation. The minimum size cable to accommodate a given short-circuit current shall be based on allowable temperature.

Cable shall be large enough to accommodate sufficient fault current to activate protective devices for an end of run fault.

6.4.3.9 Spare Raceways and Cables

Conduits

Where conduits are installed in underground duct banks, 10 percent spare conduits shall be included in each duct bank, minimum two conduits between manholes or major pullboxes.

Where overhead exposed conduits are installed in major groups or banks between two locations, 10 percent spare conduits shall be installed between junction box locations, minimum two conduits.

Cable Trays

Cable trays shall be sized to include 10 percent minimum spare capacity, based on cable fill of circuits routed. Supports for trays shall be designed to accommodate cable trays filled to 40 percent capacity.

Cables

A total of 10 percent spare conductors shall be included in routed control and instrumentation cables, in the form of either spare conductors in individual cables or spare cables, between locations where there are large numbers of terminations.

6.5 Basis of Civil and Structural Design

This criteria covers general requirements for civil and structural design including earthwork, drainage and paving, steel and reinforced concrete structures, and miscellaneous yard structures.

6.5.1 Civil Site Work Design

6.5.1.1 General

Civil design will be in accordance with the latest City of Ripon design and specification standards.

6.5.1.2 Earth Work

Earth work will include clearing, grubbing, and stripping where necessary, excavation of soils for structures and foundations, development of cut and fill slopes, and trenching for a storm drainage system, as required.

Earth work will be designed in accordance with the recommendations given in the site-specific geotechnical report.

6.5.1.3 Grading Design

The area within the project site will be graded, and if necessary, provided with supplementary catch basins to provide adequate drainage.

Finish grades will conform to the minimum drainage gradient standards indicated in Table 6-5.

TABLE 6-5
Minimum Drainage Gradient Standards

	Minimum Gradient
Concrete pavement (sheet flow)	0.5 percent
Gravel covered area	0.5 percent
Lined ditches	0.25 percent
Unlined ditches	0.30 percent
Cut, Earth	1 (vert): 2 (horiz.)
Fill, Earth	1 (vert): 2 (horiz.)

6.5.1.4 Storm Drainage Design

The City of Ripon has an existing storm drain system with storm drain piping located in South Stockton Avenue. The power plant site grade will be raised and slope (if necessary) to allow for gravity flow of stormwater via an internal collection system and subsequently to the City of Ripon stormwater system.

The plant site will primarily be covered with concrete paving, with some areas surfaced with crushed rock. Stormwater from paved areas will be routed to catch basins. Stormwater will naturally percolate within the graveled plant areas with excess water collected and sent to the City stormwater system.

Plant equipment areas such as lube oil storage areas and chemical storage areas will be provided with secondary containment berms as required to prevent contaminated stormwater from entering the City's stormwater system.

Off-site storm drainage from adjacent properties will be prevented from entering the project site, and vice versa. All buildings will be protected from flooding during a 100-year frequency storm.

Storm flow quantities for surface runoff design will be based on a 10-year frequency storm. Sumps, catch basins, and connecting storm drains will be designed for a 25-year frequency storm.

The rational formula shall be used to determine the peak runoff flow rate.

Q = CiA cfs	C =	Runoff Coefficient 0.9 for paving and roads 0.80 for roofs 0.75 for compacted earth 0.30 for gravel and open areas
	i =	rainfall intensity, inches per hour (use rain intensity frequency curves per City of Ripon Design Standards)
	A =	tributary area in acres

Runoff resulting from rainfall shall be collected by sloping the tributary surface areas to direct the runoff to catch basins. From there the surface water shall be conveyed to the City stormwater system by reinforced concrete pipe.

The site drainage system will be designed to function on the hydraulic gradient available between any two points along the system.

The storm drain system will be designed in accordance with the latest City of Ripon requirements. City of Ripon standard details shall be used wherever possible.

6.5.1.5 Hydraulic Design

The Manning formula shall be used to determine the flow of open channels and closed conduits.

$$Q = A \frac{1.486}{n} R^{2/3} S^{1/2} \text{ cfs}$$

A = cross sectional flow area in ft^2

n = for lined channels = .015
for earth channels = .030
for closed conduit = .013

R = hydraulic radius in ft

S = slope of gradient in ft/ft

Closed conduits shall be considered flowing full. Velocities shall range from 2 feet per second (fps) minimum to 10 fps maximum.

Unlined open channel velocities shall not exceed 3 fps to avoid erosion of the bottom or sides of the channel. For higher velocities, channels shall be protected with concrete lining.

6.5.1.6 Oily Water

Oil-contaminated stormwater resulting from equipment leakage, routine equipment maintenance, and oil-contaminated area washdown activities will be directed into a CPI-type oil-water separator prior to discharging into the plant drain sump.

6.5.1.7 Underground Utilities Protection

Installation of underground utilities shall be at least 3 feet below finish grade. Where such cover cannot be provided the pipes shall be encased in concrete or pipe sleeves.

Underground pipes shall be checked for traffic loads using the Marston Formula and with reference to AASHTO "Standard Specifications for Highway Bridges."

6.5.1.8 Road and Pavement

Plant roads shall be a minimum of 20 feet wide with turning radii of 30 feet inside and 50 feet outside and capable of sustaining a 40-ton axle load.

Road shall be crowned with a 2 percent slope minimum.

Roads, maintenance, and parking area shall be paved with concrete. Concrete thickness and base course requirements will be based on site-specific geotechnical report.

6.5.1.9 Striping and Pavement Markings

All edges of the traveled way shall be defined with painted lines. Roadways shall not have painted centerlines.

6.5.1.10 Fencing

The plant will be provided with a suitable security fence system.

6.5.2 Structure Design

6.5.2.1 Material Specification

Table 6-6 contains all material specifications.

TABLE 6-6
Material Specification

Anchor Bolts	Standard - ASTM A307 Grade C
	High-Strength – ASTM A325, Type 3 (Hot-dipped galvanized or stainless anchor bolts as required)
Anchor Bolts Sleeves	High Density Polyethylene Plastic
Bolts for Structural	ASTM A325-N, Bearing-Type connection or A490-N Bearing-Type Connection High Strength Bolts
Checkered Plate	Galvanized steel with safety thread ASTM A786
Concrete	Structural Concrete: Minimum compressive strength f'c=4,000 psi at 28 days
	Curbs, sidewalks: Minimum compressive strength f'c=2,000 psi at 28 days
Embedded Steel Plates	Plates shall be A36.
Grating	ASTM A569 — 1-1/4" galvanized, ASTM A123
Grout	Master Builder Embeco 713 non-shrink grout or approved equal
Handrailing	Handrails and posts 1-½" diameter standard pipe posts galvanized with horizontal spacing not greater than 12" per California code.
Ladders	Galvanized steel with 3/4" rungs at 12" O.C. Step off platforms provided at 12' maximum intervals. When ladder height exceeds 20' above grade, a cage shall be provided.
Masonry Unit	ASTM C90 Grade N-1

TABLE 6-6
Material Specification

Platforms and Walkways	Minimum widths: Operating and Maintenance Platforms: 3'—6" Walkways: 3'—0" Stairs: 2'—6"
Reinforcing Steel	ASTM A6l5, Grade 60
Steel Pipe	ASTM A53, type E or S, Grade B
Rain Water Leaders	Schedule 40 Polyvinyl Chloride (PVC) plastic pipe conforming to ASTM D1785 or equal
Storm Drain Pipe	Reinforced Concrete Pipe (RCP), ASTM C76
Structural Steel	ASTM A36
Welding Electrodes	AWS D1.1, E70XX Electrodes

6.5.2.2 Design Loads

Dead Loads (D)

Dead loads include the weight of framing, roofs, floors, walls, partitions, platforms and all permanent equipment and materials. The vertical and lateral pressures of liquids shall also be treated as dead loads.

Floors shall be checked for the actual equipment loads. For permanently attached, small equipment, piping, conduits and cable trays, a minimum of 25 pounds per square foot (psf) shall be added to floors and roofs.

Pipe loads on areas with heavy piping concentrations shall be carefully reviewed to determine the applicable design pipe loads.

Where the piping is to be supported from platforms or walkway beams, actual loads shall be determined and used.

Live Loads (L)

Live loads include floor area, laydown and equipment handling loads, lateral earth pressure and vehicles. The floor area live load shall be omitted from areas occupied by equipment whose weight is specifically included in dead load.

Operating Loads (O):

- The operating loads "O" is defined as the live load expected to be present when the plant is operating. The "O" loads shall be established in accordance with the layout and mechanical requirements.
- In the laydown areas, the actual weight of the equipment as spread out on the floor shall be considered "O."

Minimum Design Live Loads:

- Table 6-7 includes minimum live loads to be used in the design.

TABLE 6-7
Minimum Live Loads, Design

General	
Roofs	Per CBC 1998
Offices	75 psf
Assembly and Locker Rooms	100 psf
Laboratories	100 psf
Stairs and Walkways	100 psf
Railing	215 plf or 200 lbs applied in any direction at top of railing
Platforms and Gratings100 psf	100 psf
Grade Floors	250 psf
Surcharge adjacent to plant structures	250 psf
Truck support structures	AASHTO HS20-44
Forklift slab area	Max. wheel load as per vendor information for specific lifting requirements
Special Areas	
Control Room	100 psf
Switchgear Floor	250 psf
Battery Room	250 psf
Steel Grating	100 psf
Raceways	15 psf
Pipeways	Actual load but not less than 35 psf on each deck

Live Load Reduction:

- No reduction shall be allowed for warehouse storage areas.
- No reduction shall be allowed for slabs, beams, joists and girders, for loads exceeding 100 psf.
- Live load reduction shall be in accordance with CBC 1998.

Earth Pressure (Pe)
Earth pressures shall be in accordance with the recommendations from the site-specific geotechnical report.

Groundwater Pressure (Pg)
For structural and buoyancy calculations, the high groundwater table shall be as specified in the geotechnical report.

Wind Loads (W)
All structures shall be designed for wind loading in accordance with CBC 1998.

Seismic Loads (E)
All structures shall be designed in accordance with the CBC 1998.

Thermal Loads (T)
All vessels and exchangers shall be investigated for thermal expansion.

Other thermal loads caused by expansion or contraction due to a change in temperature from the erection condition shall receive proper consideration. Such loads shall include:

- forces caused by partial or complete anchorage of piping or equipment
- forces caused by sliding or rolling friction of equipment
- forces caused by expansion or contraction of the structure

Initial temperature for calculating expansion or contraction in structural design = 70°F.

6.5.2.3 Load Combinations

All structures and foundations shall be designed for the most severe load combination.

Soil Bearing Capacity
All load combinations shall be considered for checking of the soil bearing capacity.

Concrete Structure
Loads shall be combined in accordance with ACI 318.

Steel Structure
Loads shall be combined in accordance with Section 1612, CBC 1998.

6.5.2.4 Foundations

Foundations will be designed in accordance with the recommendations contained in the project geotechnical investigation.

Stability ratio of foundations against overturning and sliding for the most severe load combination shall be at least equal to 1.5.

Foundations for rotating or reciprocating equipment shall satisfy all manufacturers' requirements for design loads, deflection, and vibration limits.

The bottom of all foundations will extend a minimum of 18 inches below finished grade or as recommended by the project geotechnical report.

6.5.2.5 Design Methods

Seismic
Seismic design method shall be in accordance with CBC 1998.

Wind
Wind design method shall be in accordance with CBC 1998.

Steel

All structural steel shall be designed in accordance with the AISC 9th edition "Specification for Design, Fabrication, and Erection Structural Steel for Buildings" using the working-stress method.

Concrete

Reinforced concrete structures, except the water-retaining structures, shall be designed in accordance with ACI Specification 318 using the Strength Design Method.

Water-retaining structures, such as cooling tower basin and acid/caustic tank contaminants, shall be designed in accordance to the Alternate Design Method (ADM) per ACI 350.

The turbine generator foundation shall be an independent reinforced concrete mat foundation. The foundation shall be a low-tuned reinforced concrete structure and structurally designed in conformance with manufacturer's criteria and the following three requirements:

- **Rigidity Requirements:** The relative displacements of the bearing supports shall comply with the relative deflection criteria provided by the machine manufacturer.
- **Dynamic Requirements:** The TG foundation shall be designed as a low-tuned concrete structure. Natural mode analysis shall be performed to assure that the fundamental vertical and horizontal frequencies of the structure do not fall within the range of the machine operating frequencies as specified by the manufacturer. In addition, the rotor unbalance forcing function, during both normal operating condition and accidental condition, shall be applied to ensure that possible vibration of the structure does not result in velocities or accelerations exceeding manufacturer's specifications.
- **Strength Requirements:** The TG foundation shall be designed to retain structural integrity during all operating and accidental condition loads that might be expected to occur during the life of the plant. The design forces, related to earthquake motion or machine accidental events, shall be determined on the basis of energy dissipation in the linear (elastic) range of response.

Bonding at construction joints shall be developed by roughening the surface of the existing concrete in an acceptable manner and keeping the surface wet for at least 2 hours prior to concrete placement. Bonding mortar or other surface treatment of concrete surfaces shall not be used.

Water stops will be used at construction joints where water containment is required (i.e., sumps, cooling tower basins, etc.)

6.5.3 Seismic Design

6.5.3.1 General

Seismic design shall be based upon the California Building Code, 1998 edition, Seismic Zone 3 and occupancy importance factor I = 1.0.

6.5.3.2 Equipment Anchorage and Supporting Structures

All major equipment anchorage and supporting structures shall be designed in accordance with CBC 1998.

6.5.4 Wind Design

6.5.4.1 General

All buildings, structures, and outdoor equipment shall be designed to withstand the effect of wind from any horizontal direction.

Wind design shall be based upon the California Building Code, 1998 edition with basic wind speed of 80 mph, Exposure C, and Importance Factor 1.0.